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CHEMICAL COMPOSITION AND PHYSICAL PROPERTIES OF SOIL SAMPLES FROM COCONUT GROVES [1]

J. R. Velasco, R. K. de la Fuente, E. B. Pantastico
R. S. de la Peña, and Arcelia Alfonso-Alejar [2]

This study roughly confirms the previous findings of the writers that available aluminum was higher and available copper was lower in soils of cadang-cadang affected groves than those of groves not affected with the disease. The soils in coconut groves are very heterogeneous and may call for more detailed study in order to elucidate the cadang-cadang problem.

In a recent paper, Velasco, *et al.* (1959) indicated that available aluminum in two Bicol soil samples was much higher than in College soil. This finding and other supplementary evidence made them suspect strongly that cadang-cadang could be caused by toxic levels of aluminum. However, one principal shortcoming of their work was admittedly the meagerness of their samples. In order to remedy this defect, more soil samples were gathered and their chemical and physical properties studied.

The study reported here was made in the Department of Agricultural Botany from September to November, 1959.

MATERIALS AND METHODS

Soil Samples

Soil samples from the Bicol Region were gathered from Prieto Diaz, Sorsogon, in the south, to Baao, Camarines Sur, in the north. Similar samples were gathered from Atimonan, Quezon, to College, Laguna. The original plan was to have a continuous and regularly spaced series of samples from the southernmost tip of the Bicol Peninsula to College, Laguna, but it was later abandoned for practical reasons. As the samples presently stand, the former group represents the cadang-cadang area and the latter (Atimonan to College), the non-cadang-cadang area.

[1] Central Experiment Station Contribution No. 2022. Part of Research Project No. 1097.
[2] The writers are grateful to Mr. Juan Naron of the Guinobatan Expt. Station, for assistance during the collection of soil samples in the Bicol region, and to Mr. Bonifacio Mercado for his part in that of the Laguna-Quezon samples.

Sample sites were spaced at 10 to 20 kilometer intervals. The samples were obtained with a soil auger to a depth of 30 centimeters at a radius of one meter around the base of the trunk. About one kilogram of the pooled samples was taken from each site. The samples were air-dried and pulverized to pass a 20 mesh sieve.

The general characteristics of the sample sites and their vegetation follow:

Sample 1. Lupi, Prieto Diaz, Sorsogon. Mainly composed of white calcareous sand—the site being on the seashore, just about 10 meters from the shoreline at high tide. Most plants were littoral species. Coconut trees, 14 meters or taller, were unproductive and visibly affected by cadang-cadang. Trunks of tall dead coconut trees still stood. Coconut trees much shorter than 14 meters were productive, but old leaves seemed scorched.

It had been claimed that until about five years ago, the tall trees were producing heavily.

Sample 2. Near Kilometer Post Number (Km. No.) 637, Prieto Diaz, Sorsogon. Swampy and just beside a salt-water fishpond. Topsoil was clay, but a few inches beneath was sand; generally gray to black. Ferns, grasses, and nipa were the conspicuous species present. Coconuts were about 6 meters tall; yellow and unproductive; can be classified as cadang-cadang.

Sample 3. Km. No. 624, Gubat, Sorsogon. The area was at about sea level and for the most part swampy; soil, sandy. Vegetation consisted of Auxonopus, Themeda, and Melastoma. Melastoma had many bright red leaves, indicating unhealthy conditions. Coconuts were about 10 meters tall, with poor growth; but conspicuously yellow; had about 10 nuts per tree.

Sample 4. Km. No. 607, Gubat, Sorsogon. A former coconut area, converted to rice field; in most cases rotting stumps jut out in the rice paddies. Plants in the vicinity were cogon, Elephantopus and Mimosa. Mimosa had occasional yellow leaves. Coconuts were about 10 meters tall; badly affected by cadang-cadang.

Sample 5. Km. No. 577, Cumadcad, Castilla, Sorsogon. The area was on a very steep slope. Elephantopus leaves were yellow at margins. Coconuts were poor, 6 to 8 meters tall; affected by cadang-cadang; fruits 3 to 5 per tree.

Sample 6. Km. No. 564, Putiao, Pilar, Sorsogon. Topsoil was sandy up to 20 cm. deep; subsoil, sticky brown clay. Partly weathered shells littered the place. Cogon, cadios, and other volunteer plants were apparantly normal. Coconuts were about 12 meters tall, medium bearing (about 30 nuts per tree). About 10 kilometers before this place and on to about 10 kilometers after this, the coconut trees seemed to be relatively healthy.

Sample 7. Bankerohan, Albay, Albay. This was about 8 meters away from site of Sample 8. Coconut tree was about 14 meters tall; cadang-cadang affected; leaves green but flabby; no fruits.

Sample 8. Bankerohan, Albay, Albay. This was in the seed selection project of the Guinobatan Experiment Station; around Tree No. 127. Coconut tree was about 12 meters tall, healthy, green and heavily fruiting. This area (Samples 7 and 8) was planted to upland rice and fertilized with N-P-K fertilizer.

Sample 9. Insect-transmission project, Guinobatan Experiment Station, Banao, Guinobatan, Albay. Cogon had yellow stripes, which may suggest abnormal nutritional condition. Coconuts, about one year old; had translucent, water-soaked spots.

Sample 10. Nasisi, Ligao, Albay. The sample was taken around Tree No. 78, of our experiment on the effect of copper sulfate; previously treated with copper, nitrogen, phosphorus, and potassium. The tree was healthy and had 55 nuts; about 15 meters tall. Other trees, 6 meters away, were badly affected with cadang-cadang.

Sample 11. Km. No. 512, Polangue, Albay. The place was at the edge of rice fields. It was just a tenant's home-lot with about 13 coconut trees. Trees were about 16 meters tall and all affected with cadang-cadang.

Sample 12. Km. No. 501, Bato, Camarines Sur. Soil was heavy black clay; very close to rice paddies. Trees were about 8 meters tall; unthrifty and yellow; doubtful case of cadang-cadang.

Sample 13. Km. No. 484, Iriga, Camarines Sur. The tree was unthrifty but not yellow; in the immediate vicinity were trees that may be classed as cadang-cadang.

Sample 14. Km. No. 474, Baao, Camarines Sur. Trees were about 14 meters tall and affected by cadang-cadang.

Sample A. Km. No. 172, Atimonan, Quezon. Soil was brown sandy loam; at foot of mountain. Underbrush consisted of guava, Melastoma, and pandacaqui. Coconuts were about 14 meters tall; healthy with 40 nuts; had yellow blotches on old leaves.

Sample B. Km. No. 152, Pagbilao, Quezon. Soil was brown clay loam; at foot of mountain; cover-cropped with *Calopogonium coerolum.* Coconuts were about 14 meters tall; very healthy and dark green, with 40 to 50 nuts.

Sample C. Km. No. 141, Lucena, Quezon. Soil was brownish clay loam; on steep slope between hill and river. Underbrush was rank and grove, apparently unkept. Coconut trees were about 12 meters tall; with sparce crown; bronzing. Nuts were less than 10 per tree; constricted at basal half, like some nuts in San Miguel Estate.

About four kilometers from this place on the Pagbilao side, coconut groves on a three-kilometer stretch were strikingly yellow and unhealthy.

Sample D. Km. No. 121, Sariaya, Quezon. Surface soil was gray to black; subsoil, black. There were big boulders of volcanic origin, similar to those observed around Mt. Mayon. Coconut trees were about 10 meters tall; green, but with sparse crown and short straight leaves, sticking out like oversized badminton shuttlecocks. Fruits, less than 20 per tree.

Sample E. Km. No. 106, Tiaong, Quezon. This was on the Bureau of Plant Industry Coconut Station; around Tree No. 11-47. Tree was about 14 meters tall, unhealthy and with 6 nuts. Most trees on this part of the Station were unhealthy.

Sample F. Km. No. 90, San Pablo City. Coconut trees were about 20 meters tall, but still fruiting. Leaves, short and not arching but still normal green. This was considered as one of the oldest groves, estimated at 70 years.

Sample G. Km. No. 75, Calauan, Laguna. The grove was on elevated land, of brown clay loam and adobe hardpan. Coconut trees were about 4 years old; interplanted with pineapple. Complete fertilizer was applied twice a year at 10 grams per pineapple hill.

Sample H. Coconut grove near Higamot Hill, College, Laguna. Coconut trees were about 14 meters tall; healthy, with about 30 nuts per tree.

Methods of Analysis

Physical properties. The colors of the dry and moist samples were determined with the use of the Munsell Soil Color Chart. This chart is divided into plates corresponding to certain regions of the spectrum. For example, Plate 10YR is in the yellow-red; Plate 2.5Y is yellow. The upward graduation of any plate is according to increasing lightness (value) or from absolute black to absolute white; its graduation towards the right is according to increasing purity (chroma) from absolute gray to the pure color.

The hydrometer method (Bouyoucos, 1927; Tyner, 1940; Brady, *et al.,* 1956) was used in determining soil texture.

Soil pH was determined on a 1:1 aqueous extract using a Beckman pH Meter.

Chemical composition. The total constituents, with the exception of nitrogen, were determined on the solution obtained after sodium carbonate fusion. The available constituents were determined on the extract obtained with Morgan's sodium acetate-acetic acid reagent. Whenever feasible colorimetric procedures of determination were adopted. Phosphorus was determined as molybdenum blue; potassium as the colored salt of cobaltinitrite; iron was reduced with hydroxylamine and then determined by the o-phenanthroline method; manganese was oxidized to permanganate with sodium bismuthate; calcium was determined turbidimetrically as the oxalate.

The red aluminum lake with aurin tricarboxylic acid (aluminon) was taken as the measure for aluminum. The reagent used was synthesized using the method of Sherrer and Smith (1938). Before aluminum was determined, iron was removed with ether as the thiocyanate. Considerable dilutions were made because this method is good only at low concentrations of aluminum. Copper was determined as the golden-brown salt of diethyl-dithiocarbamic acid. Iron and aluminum were removed as hydroxides prior to the formation of the colored copper compound (Frear, 1939, cited by Snell and Snell, 1949).

The semi-micro modification of the Kjeldahl Method for nitrogen was adopted. The A. O. A. C. procedure were used for sodium fusion of the soil sample, gravimetric determination of silica, and the loss on ignition.

RESULTS AND DISCUSSIONS

In one project of the Guinobatan Experiment Station, Mr. Alfredo Magnaye and his men excavated the root systems of coconut trees on the station grounds which were about 15 meters tall. They found that some roots extended up to 5.4 meters (18 feet) away from the base and 1.8 meters (6 feet) below the soil surface. One of the present writers (J. R. V.) happened to observe the excavations and was greatly impressed by the heterogeneity of the soil. Also, thin layers of pure volcanic cinders were noticed at frequent intervals.

In view of these observations, one would not find it hard to conclude that these soil samples, obtained from borings up to 30 cm. deep and at a radius of one meter from the base of the trunk, are hardly representative of the soil in the feeding zone of the roots. The method of sampling was just an expedient measure and allowance should be made for its obvious limitations.

The physical properties of the samples are presented in table 1. Apparently, cadang-cadang occurred in soils ranging in color from black to yellowish brown. It would seem therefore that soil color can not be a criterion for suspecting or predicting cadang-cadang outbreak in any particular area. There is, however, a very slight suggestion of an association between gray or dark brown soil and the severe form of cadang-cadang. It may be pointed out for instance that in yellowish-brown soils (dry sample) coconut trees have no cadang-cadang or started to get it when they were beyond ten meters tall.

Cadang-cadang tended to be mild in a heavy soil (silt or clay), provided that it was well drained. But, again, there are many exceptions to this observation.

The pH of the samples roughly ranged from 5 to 6, with the exception of Sample 1 (Prieto Diaz, Sorsogon), which had pH 8.22. Because there was no difference in pH between the cadang-cadang and non-cadang-cadang areas, this might not be a primary factor in cadang-cadang incidence. However, it has been recognized that the slightly acidic condition of the soil might trigger the release of harmful soil constituents (Pandalai *et al.*, 1958) and indirectly bring about the unhealthy condition in plants. They reported that the healthy coconut groves in Travancore-Cochin, India, have soil pH

TABLE 1.—*Physical properties of soil samples*

SAMPLE NO.	SOIL COLOR				SOIL TEXTURE				
	Dry samples		Moist samples		Per cent sand	Per cent Silt	Per cent clay	Textural name	pH
	Value	Hue	Value	Hue					
1	10 YR 8/4	Very pale brown	10 YR 6/4	light yellowish brown	100.00	00.00	0.00	Sand	8.22
2	10 YR 4/4	Dark yellowish brown	10 YR 3/3	dark brown	—	—	—	—	5.85
3	10 YR 4/2	Dark gray brown	10 YR 3/1	very dark gray	61.96	32.04	8.00	Sandy loam	5.80
4	10 YR 4/3	Dark brown	10 YR 2/2	very dark brown	34.18	57.82	8.00	Silty loam	5.95
5	10 YR 5/4	Yellowish brown	10 YR 4/4	dark yellowish brown	12.18	61.82	26.00	Silty loam	5.50
6	10 YR 6/4	Light yellowish brown	10 YR 5/6	yellowish brown	60.45	31.55	8.00	Sandy loam	5.22
7	10 YR 5/4	Yellowish brown	5 YR 4/3	reddish brown	14.73	61.27	24.00	Silty loam	4.98
8	10 YR 5/6	Yellowish brown	5 YR 4/4	reddish brown	15.56	58.44	26.00	Silty loam	5.05
9	10 YR 5/3	Brown	10 YR 3/2	very dark gray brown	62.44	33.56	4.00	Sandy clay	5.05
10	10 YR 3/4	Unnamed	10 YR 2/2	very dark brown	81.56	14.44	4.00	Loamy sand	6.05
11	10 YR 3/2	Very dark gray brown	10 YR 2/1	black	72.22	20.78	7.00	Sandy loam	6.20
12	10 YR 2/2	Very dark brown	10 YR 2/1	black	46.81	39.19	17.00	Loam	6.05
13	10 YR 3/3	Dark brown	10 YR 2/2	very dark brown	84.64	6.36	9.00	Loamy sand	6.05
14	10 YR 2/2	Very dark brown	10 YR 2/1	black	52.08	36.92	11.00	Sandy loam	5.90
A	10 YR 6/4	Light yellowish brown	10 YR 5/4	yellowish brown	76.96	18.64	4.40	Sandy loam	5.12
B	10 YR 6/3	Pale brown	10 YR 4/3	dark brown	41.95	44.65	13.40	Loam	5.42
C	10 YR 5/4	Yellowish brown	10 YR 3/4	unnamed	20.15	64.65	15.20	Silty loam	5.05
D	10 YR 6/3	Pale brown	10 YR 4/3	dark brown	84.32	10.48	5.20	Loam sand	5.15
E	10 YR 5/3	Brown	10 YR 3/3	unnamed	17.30	65.50	17.20	Silty loam	5.90
F	10 YR 5/4	Yellowish brown	10 YR 3/3	unnamed	60.62	32.38	7.00	Sandy loam	6.05
G	10 YR 4/4	Dark yellowish brown	10 YR 3/4	unnamed	20.62	60.38	19.00	Silty loam	5.65

ranging from 6.2 to 7.2. Most of the diseased groves in their report have soil pH from 4.6 to 5.8.

The chemical constituents are presented in table 2. The range of available phosphorus was 1.4 mg. per 100 grams of soil (mg. per cent) in Sample A to 13.4 in Sample 13; available potassium, from 3.6 mg. per cent in Sample A to 47.2 in Sample E; available iron, from 0.2 mg. per cent in Samples 1, 5, E. and H, to 1.9 in Sample 2; total iron, from 0.15 per cent in Sample 1 to 11.2 in Sample 5; and available manganese, from 0.03 mg. per cent in Sample 4 to 4.5 in Sample E. The unhealthy condition of coconuts in the last site (B.P.I. Coconut Experiment Station, Tiaong, Quezon) may be ascribed to the high level of manganese. The same may be said of Sample C (Lucena, Quezon). On the same basis, the coconuts in Sample G (Calauan, Laguna) may be expected to be likewise unhealthy. That the expectation does not seem to be confirmed is probably ascribable to the fact that the plants are still young, or to negation of the bad effects of manganese by some other soil constituents.

Each of the above-mentioned constituents does not show a pattern of variation in concentration which will lead one to suspect that it might be associated with the cadang-cadang problem.

Available aluminum ranged from 0.8 mg. per cent in Sample 1, (Prieto Diaz, Sorsogon) to 14.7 in Sample 4, (Gubat, Sorsogon). If an arbitrary level of safety is set at 2.5 mg. per cent (or roughly ten times the upper limit of safety found in culture solutions), it will be noted that 8 out of 14 Bicol samples or 57 per cent exceeded this level, while 3 out of 8 Laguna-Quezon samples or 37 per cent are in that category. Another aspect of the aluminum situation worth noting is that at least four Bicol samples had exceedingly high contents of available aluminum (i.e., 3 to 6 times the arbitrarily chosen safe level), while none of the Laguna-Quezon samples had that high a level. Only Sample D (Sariaya, Quezon) had about twice as much aluminum as the arbitrarily set upper limit of safety. Unfortunately, the area represented by this sample had very poor growth of coconuts and the writers would not be surprised if the proponents of the virus theory would some day discover that cadang-cadang had "struck" in this place. The six low-aluminum-containing samples obtained around cadang-cadang affected trees in the Bicol region may call for some speculation. One possibility is that the subsoil in these places is rich in aluminum. Excavation of the feeding zone

TABLE 2.—*Chemical constituents of soil samples*

SAMPLE NO.	AVAILABLE CONSTITUENTS IN MG./100 GRAM						TOTAL CONSTITUENTS IN PER CENT					
	P [a]	K [a]	Fe [a]	Mn [b]	Al [a]	Cu [a]	N [a]	Al [b]	Ca [b]	Fe [b]	SiO_2 [b]	Loss on ignition
1	2.8	4.2	0.2	0.8	0.8	0.02	0.14	5.53	78.90	0.15	2.25	4.51
2	2.4	22.8	1.9	1.1	1.7	0.03	0.18	17.55	8.94	2.71	84.26	7.60
3	5.1	16.5	1.3	0.1	6.9	0.04	0.25	20.33	4.49	2.15	77.68	9.84
4	10.4	27.7	1.6	0.03	14.7	0.02	0.63	29.80	9.76	5.35	58.14	19.44
5	5.2	12.8	0.2	2.6	4.6	0.09	0.14	25.75	9.37	11.26	41.34	13.47
6	2.2	7.7	0.6	0.5	2.3	0.04	0.12	20.51	9.57	2.36	58.27	4.86
7	5.0	12.9	0.5	1.3	4.2	0.09	0.27	23.10	10.80	10.97	38.49	15.92
8	5.3	15.7	0.5	0.2	4.2	0.18	0.23	25.90	10.13	7.33	38.34	16.53
9	5.5	19.3	1.4	0.4	8.0	0.08	0.24	30.98	10.06	6.43	56.79	4.90
10	5.3	11.4	0.9	0.2	7.0	0.28	0.27	18.52	7.48	5.35	53.11	5.10
11	10.2	26.7	0.3	0.3	1.2	0.04	0.27	16.97	4.70	4.99	60.02	5.56
12	9.6	9.1	0.5	0.4	1.1	0.04	0.16	12.95	8.33	5.46	57.00	8.18
13	13.4	29.9	0.9	0.2	5.2	0.13	0.37	15.37	10.04	6.30	64.00	10.13
14	9.5	42.9	0.3	0.8	1.3	0.06	0.21	13.08	9.78	7.52	48.58	8.33
A	1.4	3.6	0.9	1.0	3.6	0.05	0.10	20.50	7.10	3.72	57.66	2.83
B	4.5	22.4	0.5	2.3	1.4	0.08	0.23	11.25	6.98	6.01	57.51	8.96
C	5.7	12.3	0.7	3.3	2.5	0.12	0.24	11.01	6.24	7.29	47.31	7.42
D	2.6	27.7	1.7	0.8	5.4	0.15	0.12	17.69	6.01	5.72	55.66	3.16
E	7.2	47.2	0.2	4.5	1.3	0.15	0.14	13.25	7.59	6.18	56.72	5.85
F	8.2	38.8	0.6	0.5	3.5	0.06	0.20	16.19	7.40	5.69	51.25	4.45
G	19.0	20.2	0.4	3.5	2.0	0.24	0.16	17.99	7.20	9.36	47.62	6.67
H	12.7	35.9	0.2	0.8	1.7	0.29	0.13	15.80	10.02	7.30	51.26	

[a] Average of three determinations.
[b] One determination.

of the roots may prove enlightening. Another possibility is that the malady is entirely of a different nature from that observed in Guinobatan.

Total aluminum is in general higher in the Bicol samples than in the Laguna-Quezon samples. If 15 per cent total aluminum were to be taken as a benchmark, it will be noted that 11 out of 14 samples from the Bicol region or 78 per cent exceeded it while 5 out of 8 or 62 per cent of the Laguna-Quezon samples did likewise. Some samples from the Bicol region had exceedingly high total aluminum contents (25 to 30 per cent). There seemed to be no strict correspondence between available and total aluminum contents. This may be taken to mean that several contributing factors condition the release of aluminum from the parent material.

Available copper was generally higher among the Laguna-Quezon samples. This roughly confirms the previous findings by the use of the *Aspergillus niger* bioassay technique. With this technique, Velasco *et al.* (1957) found 2.5 μg. of copper per gram of College soil. The same soil (Sample H) was found to contain 2.9 μg. of copper per gram (table 2) by the colorimetric method used in this study.

Total nitrogen ranged from 0.10 per cent in Sample A to 0.63 in Sample 4; total calcium, from 4.49 per cent in Sample 3 to 78.9 per cent in Sample 1; and total silica, from 2.25 per cent in Sample 1 to 84.26 in Sample 2. Per cent loss on ignition ranged from 2.83 in Sample A to 19.44 in Sample 4. This is an approximate measure of organic matter in the soil. Again, these constituents do not seem to be related to the cadang-cadang problem. At this point, one caution seems pertinent: because the figures for available manganese, and total aluminum, calcium, iron, silica, and loss on ignition were obtained from single determinations, any deduction made on them should be held as highly tentative. The inadequate determinations were dictated by limitations of laboratory facilities or by insufficient samples.

To summarize, it may be said that of the soil constituents studied, only available aluminum and copper seem to merit further consideration as factors in the cadang-cadang problem. These data strengthen the previous suspicion (Velasco *et al.*, 1959) that cadang-cadang is caused by toxic levels of available aluminum and/or deficiency of copper.

The present indications are probably clear enough to allow a little digression or speculation on what lies in prospect. Some questions which may invite an answer are: (1) Can it be definitely presumed that all the unhealthy conditions of coconuts in the Bicol region otherwise known as cadang-cadang arise from the same cause or causes? (2) What makes aluminum so patently toxic to coconuts and apparently innocuous to other species? (3) What experiments may be initiated in order to confirm or negate the hypothesis that cadang-cadang is caused by aluminum toxicity and/or copper deficiency? (4) Assuming for the sake of discussion that there is a real tie-up between these soil constituents and cadang-cadang, what can be done to remedy or alleviate the condition? (5) How much reliance may be placed on a given remedy, or how immediate can results be expected?

1. Because there is no definitive symptoms of the disease, any coconut tree which has water-soaked specks, is emaciated or unproductive, and dying is considered cadang-cadang affected; provided, that it is in the Bicol region or in the neighboring areas where the "virus" could have conceivably spread. As a consequence, trees which are dark green as well as those which are yellow or bronzing; trees with short stiff leaves (spread like a shuttlecock) as well as those with weak drooping leaves; trees with trunks that taper and those which don't; and trees with elongated fruits as well as those with small rounded fruits flattened at the stigmatic end are all thrown in the class of cadang-cadang. With such a diversity of symptoms, it will not be hard to suspect that the malady could be of diverse nature and could have been brought about by various causes.

2. Aluminum is not so selective a poison as to pick out coconut among the many species. It affects other plants just as much as coconuts, if not more. But at the intermediate concentration that it is found in most Bicol soil it just acts as a mild root poison, and impairs the water economy of the plant. With short plants like rice, tomato and citrus, an impaired water economy may not be critical. However, as a plant grows taller, it meets with increasing difficulty to mobilize water from the roots to the leaves. The plant may make some adjustments by shedding off some of its leaves but this is at best staving off eventual death. The adverse effect is most prominent on coconut because once its shoot dies, the whole plant dies. In contrast, a tall pili or ilang-ilang tree may lose its tallest twig, but the lower branches will continue to live and the plant does not die.

3. One experiment which the writers would like to start involves the construction of a big concrete tank which would be filled with soil from a non-cadang-cadang area. Coconut trees adjudged to be affected by cadang-cadang will be balled, washed free of soil and transplanted to this tank. If the disease is caused by a detrimental soil constituent, this change for a better soil environment should enable the trees to recover. As soon as money becomes available to them, the writers will start this experiment and other related ones that may stem from this.

4. As a corrective measure for copper deficiency in the soil, weak solutions of copper sulfate may be sprayed on coconut leaves or poured into the clasping leaf bases.

To correct excessive aluminum, the soil may be limed in order to raise its pH. At pH 7 and 8 aluminum compounds are less soluble. Application of phosphatic fertilizers will also be helpful because this will combine with aluminum to form the insoluble aluminum phosphate. So as not to aggravate aluminum toxicity, acid-forming fertilizers like ammonium sulfate should not be used. As source of nitrogen urea or the nitrate may be better for the cadang-cadang area.

5. Any treatment to cure cadang-cadang is apt to be painstaking and slow: first, because the coconut reacts quite slowly to treatments; secondly, because any treatment like liming or application of phosphatic fertilizers is bound to affect immediately only a few centimeters deep of the soil. It may require a series of regular applications to ever affect the whole volume of soil in the feeding zone which extends to 1.8 meters deep.

However, the situation is not entirely hopeless. Together with the good practices of managing the soil, a program of coconut breeding should be initiated. Thus we may yet develop an early-maturing, high-yielding variety which can better withstand the limitations of this peculiar environment.

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EXPERIMENTAL CULTIVATION OF *VOLVARIA VOLVACEA* (BULLIARD) QUELET [1]

LEONARDO K. GO [2]

Like most fungi, *Volvaria volvacea* grows best in potato-dextrose agar, and in malt agar. In a potato-dextrose agar slant (¾″ × 6″ test tube), the culture remained viable up to six months, and in rice grain medium (1″ × 8″ test tube), up to nine months.

The two mushroom species (*V. volvacea* and *V. bresadolae*) thrive better in warm than in cold temperature. Fresh rice straw could be used to obtain higher temperature. It is also commendable, since its pH value is generally above 8.0, and the fungus grows well at such a pH range.

Aside from these, fresh, dry rice straw minimizes growth of competitive fungi. Weed fungi may overtake *Volvaria* in an old, moist substrate.

Fresh coffee pulp spawn was the best among a number of spawn tested. If treated horse manure spawn could be used, the dosage of insecticides may be considerably reduced so as to allow better mycelial growth and at the same time remain effective in repelling insects and other related animals.

In the experiments, the height of the rice straw beds was about 1¼ feet. For actual practice, however, the height may be raised considerably.

A location in the shade of trees or bamboos, or under a simple nipa or cogon roof is suitable for *Volvaria* cultivation.

In harvesting, complete removal of the sporophore is important because any remnant may harbor pests and diseases.

WITH SEVEN TEXT FIGURES

In recent survey, Van Muijzenberg (1955) estimated the total annual world production of cultivated mushrooms to be 75,000,000

[1] Central Experiment Station Contribution No. 2024. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, U.P., March, 1959. Prepared in the Department of Plant Pathology under the direction of Dr. Lewis A. Schafer, Cornell Visiting Professor, Instructor Mario O. San Juan, and Asst. Instructor Romeo V. Alicbusan.

[2] Grateful acknowledgment is due Dr. Faustino T. Orillo, Department Head, and Mr. Romeo V. Alisbusan for the encouragement of the work; and Mr. Godehardo B. Calleja, a fellow major student, for valuable suggestions in the preparation of the manuscript.

kilograms, and that of wild species, 25,000,000. This production, is distributed as follows: Holland, 500,000 kilograms; Belgium, 700,000; England, 15,000,000; France, 20,000,000; the United States, 30, 000,000; and other countries, about 8,800,000. Manchester [3] reported that in the United States alone the industry is backed with an investment of 50 million dollars by same 900 growers. Ito and Imai (1925) reported for Japan and China an annual yield of several million kilograms of *Cortinellus berkeleyanus*. This figure may fall under the category of wild mushrooms in van Muijzenberg's report.

The cultivated mushroom mentioned above refers to a single species, champignon or field mushroom, *Agaricus* (*Psalliota*) *campestris*. In the western hemisphere, *A. campestris* is the most popular species among a long list of edible fungi, although morels (*Morchella* spp.) are the most prized ones.

In the Philippines, native species like *Collybia* spp. and *Volvaria* spp. are highly prized. *Volvaria volvacea* and *V. bresadolae* (= *V. esculenta* Bres.), because of their wide range of substrates (rice straw, banana stalk, abaca remnant, corn stalk, sugarcane and ramie bagasse, cotton waste and gunny or jute sack), have been grown on a trial scale by the farmers in the province of Pampanga and in the Bicol region since the beginning of this century. Vicencio (1917) attempted a series of experiments by duplicating the native methods of mushroom production. Among media tried were rice-wash on rice straw, common salt brine on rice straw, sugar-cane bagasse, and banana stalk. Owing to lack of pure culture spawn, the experiments were not successful. Vicencio's work, however, initiated the local pursuit for artificial propagation of edible fungi, and the report serves as a good record of the native ways of mushroom culture. Benemerito (1935) and Espino (1936) of the College of Agriculture, University of the Philippines, made reports on mushroom culture in Canton, China.

Although the cultural method is known and the tropical climate of the Philippines is suited for rice straw mushrooms, no commercial production of these species has been reported. On the other hand, a temperate zone species, *Agaricus campestris*, is produced in the vicinity of Baguio City and also in Mandaluyong, Rizal. Up to now the Philippines still imports mushrooms amounting to ₱150,000 annually (table 1).

[3] H. Manchester. The Christian Science Monitor, September 9, 1957.

TABLE 1.—*Mushroom importation in the Philippines* * *(expressed in pesos) from 1953 to 1957*

YEAR	ORIGINS OF IMPORTATION [a]					TOTAL ANNUAL IMPORTATION	
	U.S.A.	France	Japan	Hongkong	Other nations [b]		
1953 (A)	—	—	11,572	47,544	—	59,116	148,296
(B)	71,688	12,290	—	5,202	—	89,180	
1954 (A)	3,476	3,480	72,380	30,932	—	110,268	172,102
(B)	10,974	12,936	19,268	18,656	—	61,834	
1955 (A)	5,394	—	89,240	14,112	4,110 [c]	112,856	187,690
(B)	39,472	20,896	—	4,776	9,690	74,834	
1956 (A)	5,182	4,644	90,880	2,660	8,552	111,918	187,820
(B)	40,330	17,350	2,374	8,656 [d]	7,192	75,902	
1957 (A)	720	—	62,478	3,496	642	67,336	146,436
(B)	62,704	7,334	—	4,804	4,248	79,100	

[a] Mushrooms from Japan and Hongkong are mostly *Cortinellus berkeleyanus* and *Auricularia auricula-judae;* those from U.S.A., France and other nations (probably except Burma) are *Agaricus campestris.*

[b] Including Burma, Italy, Spain, Switzerland, and United Kingdom.

[c] From Burma.

[d] This figure includes ₱810 from China.

(A) Fresh (including frozen) or dried mushrooms.

(B) Processed or canned mushrooms.

* Data furnished by the Department of Economic Research, Central Bank.

The champignon is more commonly cultivated not so much because it is more preferred than rice straw mushrooms by the Filipinos but probably because the cultural principles of champignon have been well established after intensive researches made by scientists and mushroom growers throughout the world for the past 70 years. On the other hand, the routine method of raising rice straw mushrooms is rather primitive and does not give ample assurance of successful production. Intensive studies regarding these species are wanting. It is the object of this research to study the possibility of large scale production of rice straw mushrooms in the Philippines.

The work has a two-fold objective. One is to understand the physiology of the fungus, which will serve as a basis for future application in the spawn preparation and mushroom growing. The following aspects were chosen for investigation: (1) the most suitable artificial medium for maximum growth of the fungus, (2) the optimum temperature for mycelial growth, (3) the pH range necessary for the fungus, (4) the most suitable medium for spawn preparation, and (5) the viability of the fungus on various culture media. The

other is to perform the routine method of growing rice straw mushrooms to determine the possible difficulties or problems to be encountered in the cultivation, especially pests and diseases, and to devise ways of avoiding these difficulties.

The experiments were conducted from December, 1957 to February, 1959 in the Department of Plant Pathology and on the college campus.

MATERIALS AND METHODS

Isolation of Pure Culture

Volvaria volvacea in the button stage was collected from Calauan, Laguna, during the Christmas vacation of 1957.[4] Several buttons were brought to the laboratory and incubated in a damp chamber. As soon as the pileus pierced the volva, it was severed by cutting its stipe close to the gills, and was used for obtaining spores. The spores were planted on sterile potato-dextrose agar in a petri dish. Routine procedure for preventing contamination was observed. Three days later, hyphae from the germinated spores were transplanted into several potato-dextrose agar slants. These cultures were incubated at room temperature (27 to 28°C) and served as the source of inoculum for the experiments.

Physiological Studies

Artificial agar media for mycelial growth. The growth and cultural characteristics of the fungus were observed on 13 different agar media, namely; potato-dextrose agar, malt agar, mongo bean (*Phaseolus aureus*) decoction agar, peanut bean decoction agar, corn grain decoction agar, horse manure decoction agar, cow manure decoction agar, rice straw decoction agar, madre de cacao (*Gliricidia sepium*) leaf decoction agar, ipil-ipil (*Leucaena glauca*) leaf decoction agar, banana leaf sheath decoction agar, and water agar. All the agar media were sterilized and adjusted to pH 6.2 by using either sterile H_2SO_4 or sterile NaOH at N/10 or N/2. The different media were plated in separate sterile petri dishes, later inoculated with mycelial bits taken from the pure culture. Four replicates were made. All cultures were kept at room temperature and their growth rates were determined each day by measuring the diameters of colonies.

[4] Acknowledgment is due Mr. E. C. Tuason for supplying the mushrooms.

Optimum temperature. To determine the optimum temperature for mycelial growth, potato-dextrose agar in petri dishes was used. The agar plates were inoculated and incubated under different temperatures ranging from 10 to 44°C. Ten temperature levels were tested and triplicate cultures were provided for each treatment. The cultures were incubated in a calibrated refrigerator or incubator. Growth rates were measured and recorded.

pH range. To determine the effect of varying hydrogen-ion concentrations on mycelial growth, the fungus was grown on potato-dextrose agar with varying pH values ranging from 4.0 to 10.5. The pH of the medium was adjusted to the desired level by the addition of either sterile H_2SO_4 or NaOH at N/10, N/2 or 1 N. The pH levels, with intervals of 0.5, were tested. Triplicate cultures were observed at each pH level. The inoculated cultures were kept at room temperature. Growth on each dish was measured and recorded.

Viability of the fungus on some culture media. The viability of mycelia on potato-dextrose agar slants (¾″ × 6″ test tube) and in rice grain medium (1″ × 8″ test tube) were observed at monthly intervals. Bits of mycelium were transplanted into new potato-dextrose agar slants to determine the occurrence of new mycelial development.

Spawn Production

Thirty-two different preparations were made to determine the most suitable material for spawn production. Only local materials were used.

The different materials, except manures, were placed separately in flasks, plugged with cotton, and autoclaved for one hour at 15 to 17 pounds pressure. The manures were placed in ball-jars with each cap previously bored with a hole approximately 1.5 cm. in diameter. The holes were plugged with cotton. They were autoclaved for two hours at 15 to 17 pounds pressure. Four replicates were made for each treatment. Each flask or jar was later inoculated with mycelium from the pure culture. One month after inoculation, relative amounts of growth on these media were compared.

Mushroom Cultivation

To test the purity and viability of the spawn, a set of experiments on mushroom cultivation was conducted on June 19, 1958.

Another set of experiments was conducted in November and December, 1958 to find the most suitable one among the materials producing well-developed spawn. The details of these experiments are presented in a later section.

RESULTS OF PHYSIOLOGICAL STUDIES

Growth on various agar media. The most abundant mycelial growth occurred on potato-dextrose agar, followed by malt agar. Growth was fair on the decoction agars of mongo, peanut, and corn but very thin on rice decoction agar. Growth was poor on water agar as well as the decoction agars of horse manure, cow manure, madre de cacao leaf, and banana leaf sheath. No growth was observed on ipil-ipil leaf decoction agar (table 2).

TABLE 2.—*Mycelial growth of Volvaria volvacea (Bull.) Quell. on various agar media*

MEDIUM	DIAMETER OF COLONY AFTER FIVE DAYS [a]	AVERAGE DAILY GROWTH	GROWTH CHARACTERISTICS
	cm.	*cm.*	
1. Potato dextrose agar	7.85	1.57	Abundant, fluffy
2. Malt agar	8.05	1.61	Fairly abundant, fluffy
3. Mongo bean decoction agar	9.00	1.80	Fair, with some aerial growth
4. Peanut bean decoction agar	7.02	1.40	Fair, adpressed to the surface of the medium
5. Corn grain decoction agar	6.50	1.30	Fair, with aerial growth
6. Rice straw decoction agar	5.47	1.09	Thin, with some aerial growth
7. Horse manure decoction agar	7.82	1.56	Thin, with some aerial growth
8. Cow manure decoction agar	6.68	1.34	Thin, with some aerial growth
9. Rice grain decoction agar	8.80	1.76	Very thin, adpressed to the surface of the medium
10. Water agar	7.65	1.53	Extremely thin, adpressed to the surface of the medium
11. Madre de cacao leaf decoction agar	2.60	0.52	Thin
12. Banana leaf sheath decoction agar	5.75	1.15	Extremely thin, hyphae are very fine
13. Ipil-ipil leaf decoction agar	—	—	No growth

[a] Average of four cultures.

Growth at different temperatures. Unlike champignon, *V. volvacea* produces profuse mycelia in warm temperature. Cardinal tem-

peratures for *V. volvacea* are: minimum, about 15°C; optimum, 39 to 40°C; and maximum, 41 to 42°C (table 3). Those for champignon are 2°C, 23°C, and 32°C, respectively.

TABLE 3.—*Mycelial growth of Volvaria volvacea (Bull.) Quell. on potato-dextrose agar at different temperatures*

TEMPERATURE	COMPARATIVE ABUNDANCE OF MYCELIUM	DIAMETER OF COLONY AFTER 3 DAYS & 17 HOURS [a]	AVERAGE DAILY GROWTH
°C		cm.	cm.
10	None	—	—
15	Rare	0.52	0.13
20	Rare	0.73	0.19
25	Moderate	4.22	1.14
27–28	Abundant	5.43	1.46
30–31	Very abundant	7.37	1.96
34–35	Very abundant	8.25	2.22
39–40	Most abundant	10.00	2.69
41–42	Rare	1.20	0.32
43–44	None	—	—

[a] Average of three cultures.

Growth on media of varying pH. No growth was observed at pH 4.0. Thin mycelial growth appeared at pH 4.5, moderate at 5.0 to 5.5, abundant at 6.0 to 8.0, moderate at 8.5 to 9.0, scarce at 9.5 to 10.0, and rare at 10.5. The best growth was obtained at pH 7.5 (table 4).

Viability of mycelia on two kinds of culture media. A six-month old culture from potato-dextrose agar slant (¾″ × 6″ test tube) produced new mycelia after transplanting to a new potato-dextrose agar slant. The agar slant became very dry and shrunken after seven months and the culture, in most cases, failed to grow after transplanting. Nevertheless, mycelia from rice grain medium (1″ × 8″ test tube) remained viable up to nine months. It should be noted that the larger tube provided more moisture and nutrients. The viability of the fungus, therefore, depends greatly on the availability of moisture and nutrients.

Growth on various spawn materials. The results obtained from 32 different preparations were based on the comparison of the mycelial growth rates. They are therefore relative rather than absolute. The media which supported excellent mycelial growth were rice grains (with 2 per cent $CaCO_3$ by weight), fresh coffee pulp,

half-rotten madre de cacao leaves (also ipil-ipil and stringbean leaves), fresh corn cob, tobacco leaf stem, horse manure, 2:1 horse and cow manure and 2:1:1 horse manure, cow manure, and soil. Those media with good growth were corn grain (with 2 per cent $CaCO_3$); treated mongo bean, stringbean and pod, and peanut bean; composted coffee pulp; cow manure, and 1:1:1 horse manure, cow manure, and loam soil. Composted corn cob gave fair growth. Those media which gave scanty growth were rice straw, banana leaf sheath, and roots of rice, tomato, cowpea, and stringbean. Horse manure treated with either DDT, methoxychlor or dylin gave very scanty growth. Half-rotten jackfruit leaves and mongo leaves, new jute sack and old copra jute sack gave no growth at all.

TABLE 4.—*Mycelial growth of Volvaria volvacea (Bull.) Quel. on potato-dextrose agar at different hydrogen-ion concentration*

pH OF MEDIUM	RELATIVE ABUNDANCE OF MYCELIUM	DIAMETER OF COLONY AFTER 3 DAYS & 17 HOURS [a]	AVERAGE DAILY GROWTH
		cm.	*cm.*
4.0	None	—	—
4.5	Rare	0.88	0.23
5.0	Moderate	2.10	0.56
5.5	Moderate	2.67	0.72
6.0	Fairly abundant	3.20	0.86
6.5	Fairly abundant	3.95	1.06
7.0	Abundant	4.15	1.12
7.5	Very abundant	6.13	1.65
8.0	Abundant	4.10	1.10
8.5	Moderate	2.55	0.69
9.0	Moderate	2.26	0.61
9.5	Scarce	1.75	0.46
10.0	Scarce	1.04	0.28
10.5	Rare	0.70	0.19

[a] Average of three cultures.

Among the six more preferred materials for spawn production, not all gave the same satisfactory results in actual application. Their advantages and disadvantages are as follows:

Rice grain

Advantages: Raw material is easily obtained; spawn is easily applied to the bed.

Disadvantages: Only the upper portion of the grain mass had mycelial growth. Unless the grains are in a thin

mass, uniform mycelial growth is difficult to produce. Rice grain is subject to attack by rats, especially here in the Philippines where rats are rampant in almost all provinces; therefore, it seems that this kind of preparation is undesirable.

Fresh coffee pulp

Advantages: Uniform mycelial growth on both outer and inner surfaces of the pulp. It gave the most satisfactory mushroom production in actual practice.

Disadvantage: Raw material is not easily obtained.

Half-rotten-leguminous leaves (prepared from madre de cacao, ipil-ipil, stringbean)

Advantages: Raw materials are easily obtained and cheapest of all materials used.

Disadvantages: Did not produce good results in actual mushroom cultivation.

Fresh corn cob

Advantage: Raw material is easily obtained.

Disadvantages: This material encouraged growth of fungous contaminants which adversely affected mushroom production. The commonly observed fungi that grew on corn cob were *Aspergillus, Rhizopus, Penicillium, Neurospora,* and *Sordaria* species. In actual mushroom culture, it was observed that *Sordaria* almost entirely prevented mushroom production.

Tobacco leaf stem

Advantages: The mycelia grew well not only on the surface but also between the tissues. The presence of nicotine served to repel insects and some other pests.

Disadvantage: It is rather expensive because the tobacco leaf stem is mixed with the tobacco leaf blade in cigarette making.

Horse manure

Advantages: Raw material is easy to obtain. The spawn can be distributed in dry and solid form and therefore does not have to be kept in a glass jar or other container.

Disadvantages: Its preparation is more laborious. Unless a suitable insecticide is applied, this kind of spawn is likely to be a breeding place for insects and related animals, such as sowbugs, which affected mushroom culture.

The characteristics of the mycelial growth of the fungus on various grains and beans, kept inside 1" × 8" test tubes for about three months, are tabulated in table 5.

TABLE 5.—*Mycelial growth of Volvaria volvacea (Bull.) Quell. on various grains and beans*

SUBSTRATE	HEIGHT OF MYCELIA ABOVE SUBSTRATE		GROWTH CHARACTERISTICS	COLORS [a]
	Individual measurement	Average		
	cm.	*cm.*		
1. Rice grain	3.6 4.0 8.0	5.20	Abundant, formed a compact cord	Ivory, turning bran-colored in age
2. Corn grain	1.5 1.5 5.0	2.67	Abundant, formed a compact cord	Ivory, turning antique gold colored in age
3. Peanut bean	0.8 1.1 1.2	1.03	Fair, fluffy	Capucine buff
4. Mongo bean	0.5 0.5 0.5	0.50	Merely covered the surface of substrate	Leghorn, turning raffin-colored in age

[a] Color standard based on Maerz and Paul, "A dictionary of color," McGraw-Hill Book Co., Inc., New York, pp. 208 (1950).

PRODUCTION OF MUSHROOM IN RICE STRAW BEDS

Experiment 1

In the first set of experiments, two rice straw beds were prepared and were sown with a mixed spawn classified under two categories: (1) manure spawn were sown in bed I; (2) ipil-ipil leaf spawn, madre de cacao leaf spawn, and composted coffee pulp spawn were sown in bed II. All spawns were about 8 weeks old.

The site. The culture house is located near Molawin Creek and is surrounded by big trees and bamboos. The house is a ruined concrete building. The door and windows are made of bamboo slats with

wooden frames and with ample space for ventilation between the slats. The house is about 20 feet long, 14 feet wide, and 7 feet high.

Preparation of the beds. Two identical beds were made. The foundation was a layer of soaked coconut husks to conserve moisture. All rice straw needed in the preparation of the beds was previously soaked in water and trampled upon. Two layers of rice straw were arranged crosswise on top of the husks. Each layer was about 4 inches thick. The first layer of spawn was then placed along the sides of the bed, about 3 inches from the margins, with about 6-inch intervals between the pieces of spawn. Each piece of spawn was approximately the size of the thumb. Another layer of rice straw was laid on top of the spawn, but this time it was arranged lengthwise. The bed was trodden while much water was being poured. The whole procedure was repeated until three layers of spawn were sown. The reason for the interlacing of straw crosswise and lengthwise was to prevent sliding of the bed, especially when built high. It also facilitated the location of the spawn whenever necessary. The rice straw bed was more than 1 foot high, 3 feet wide and 10 feet long. A thin layer of dry straw was placed on top of the bed to prevent rapid evaporation and also to maintain temperature. Increased heat was due to the fermentation of the straw by the action of microorganisms. Consequently, the temperature in the bed rose from about 40 to 50°C. This temperature range was beneficial because it accelerated mycelial development.

Cultural practices. The beds were left undisturbed for one week, after which they were watered every other day. Too much watering was avoided to prevent lowering of the temperature in the bed and also to prevent disturbance of the mycelial growth. On hot days, however, the beds were watered daily. Three weeks after planting, the mushrooms were ready for harvest.

Observations on yield and on pests and diseases. Twenty-one days after sowing the legume-reared spawn, bed II produced its first crop. Ffteen mushrooms were harvested on the first day. A total of 88 sporophores were harvested during the first six days. Views of the sporophores at various growth stages are shown in figures 1, 2 and 3. The period of mushroom production was shortened by the severe attack of diseases. All diseased buttons (more than 50) were rogued.

Fig. 1. Pileus of two kinds of rice straw or banana mushrooms. On the left *Volvaria volvacea* (Bull.) Quel., on the right *Volvaria bresadolae Trotter* (*V. esculenta* Bres.) (*Photographed by the Photographic Division*).

Fig. 2. Top view of several sporophore clusters of *Volvaria volvacea* (Bull.) Quel. The lighter shaded ones are the buttons, and the darker ones are the mushrooms newly emerged from protective veils. (*Photographed by the Photographic Division*).

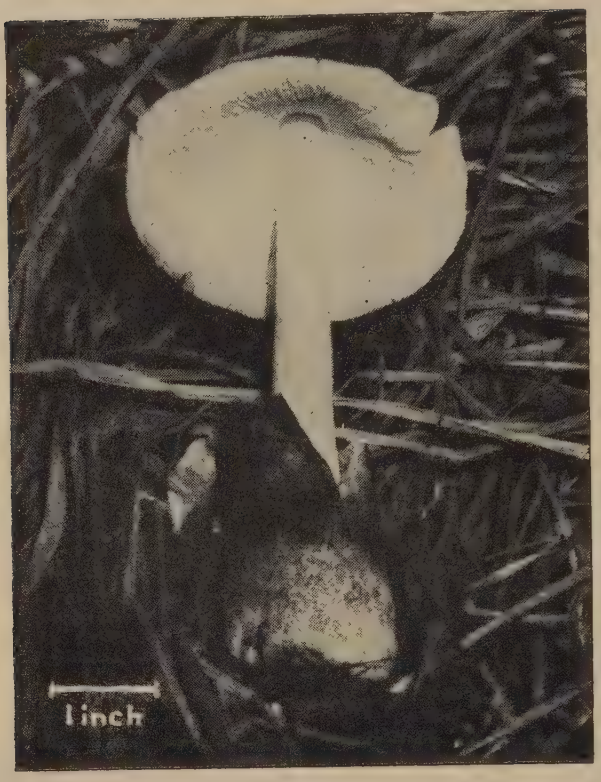

Fig. 3.—A fully expanded sporophore of *Volvaria volvacea* (Bull.) Quel. Note the large and prominent volva. (*Photographed by the Photographic Division*).

Diseased condition was observed on the fourth day. On the fifth day, it became worse and almost all buttons on the bed were rotten. They were rogued on the sixth day. The diseases could be attributed to three possible causes:

(1) Incited by *Sclerotium rolfsii*—The protective veil of the button was moist or slimy, indicating rotting, and sclerotial bodies of *S. rolfsii* were adhering to the button (fig. 4).

(2) Associated with an unidentified organism—Very fine, white, felt-like mould colonies (fig. 5) were scattered over the button, and the button eventually became wet and decayed. The colonies rarely exceeded 1 mm. in diameter; no brownish exudation was noticed. It differed from the "bubble" disease on champignon, although the pri-

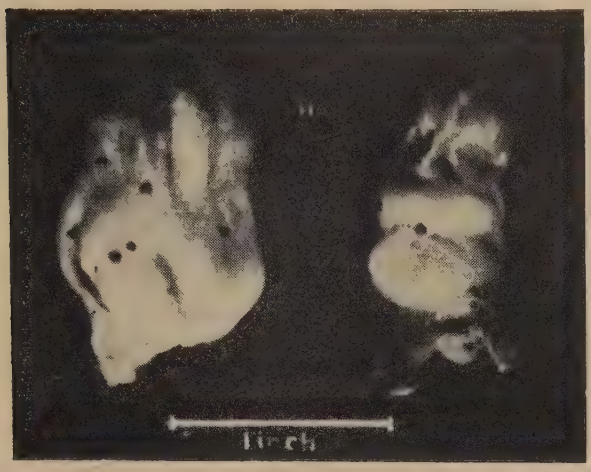

Fig. 4. Two buttons of *Volvaria volvacea* (Bull.) Quel. affected by *Sclerotium rolfsii*. Note the sclerotial bodies of the parasite adhering to the buttons. (*Photographed by the Photographic Division*).

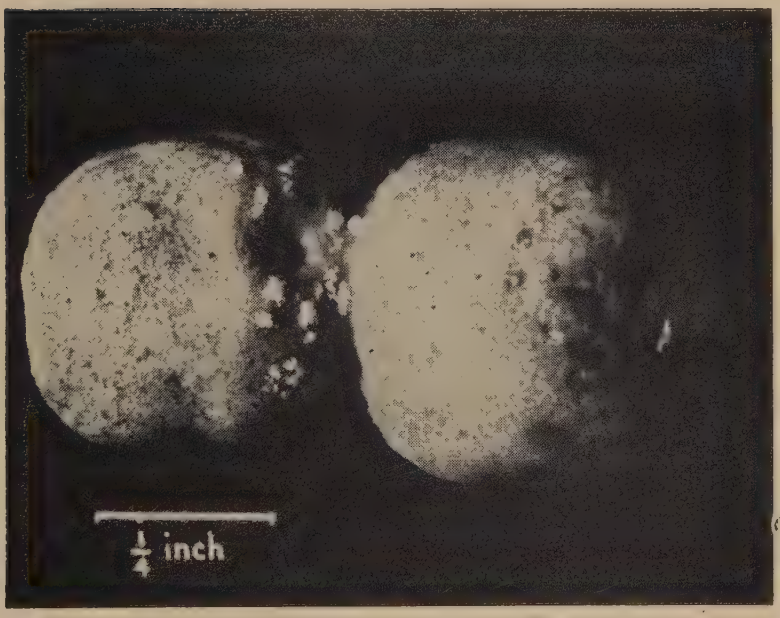

Fig. 5. *Volvaria volvacea* (Bull.) Quel. buttons affected by actinomycete-like organisms. (*Photographed by Dr. B. V. Travis*).

mary sign of white velvety growth appeared similar (Taylor, 1914; Charles and Popenoe, 1928; Beach, 1937). Under the microscope, the mycelium of the mould appeared finer than any eumycete; no fruiting body was observed. The organism probably is an actinomycete; however, it was not certain that it was the primary causal organism, since no test of pathogenicity was performed. It might be only a secondary organism or saprophyte that grew on decaying buttons.

(3) Bacterial cause—The rotten buttons did not show signs of mycelial growth or sclerotial bodies. These were the buttons remaining in the cluster after some of the mature mushrooms had been harvested two or three days previously by cutting close to the base. The disease was suspected to be due to bacteria that entered the harvested mushroom in the same cluster.

Bed I failed to produce mushroom. This was unexpected since the spawn used in this bed was prepared from horse or cow manures, and manure spawn has been employed in Europe and the United States for a long time in commercial production of champignon (Duggar, 1904; Mahoney *et al.*, 1936). The failure could be attributed to the disturbance brought about by a pest. One week after the preparation of the beds, the condition of mycelial growth in both beds I and II was inspected. Bed I was discovered to be infested with numerous sowbugs, while in bed II only insects like beetles and cockroaches were found.

On the expanded mushrooms, harmful insects such as mushrooms mites, springtails, and mushroom flies were frequently observed.

The weed fungi located on the bed were *Coprinus* spp. and a certain ochreous-brown-capped, brown-spored, frail, wild mushroom.

Experiment 2

The second set of experiments was conducted in the same site as experiment 1. Pure culture spawn prepared from five different materials were tested. They were ipil-ipil leaf spawn(sown in bed A), madre de cacao leaf spawn (in Bed B), fresh coffee pulp spawn (in beds C and D), treated horse manure spawn (in bed E), and fresh corn cob spawn (in bed F).

The materials. The ipil-ipil spawn was about seven weeks old; madre de cacao spawn, twelve weeks old; fresh coffee pulp spawn, four weeks old; treated horse manure spawn, eight weeks old; and fresh corn cob spawn, four weeks old. The rice straw was hauled from the Central Experiment Station. Banana stalks obtained from the campus were used in place of coconut husks.

Preparation of the beds. Six beds were prepared as in experiment 1, except that banana stalks were used instead of coconut husks as the foundation for the rice straw beds. Also, bamboo slats set two feet apart were erected along the sides of the beds to serve as support. The measurements of each beds A, B, C, and D were 1¼ feet high, 3 feet wide and 8 feet long, while beds E and F were of the same height and width but only 4 feet long. Beds E and F were built inside the culture house where the humidity was close to saturation. Beds A, B, C, and D were built in the open-air, on top of the culture house.

The same cultural practices were followed as in experiment 1, except as regards harvesting. The sporophores were not cut but carefully picked so that not a portion of it remained in the bed. Because of this, bacterial rot was eliminated.

Yield and other observations on the beds. Because beds A, B, C, and D were prepared in November, while beds E and F, in December, the data on them are not strictly comparable.

The highest yield of mushroom was obtained during the first six days of production when the mushroom was relatively free from the attack of pests and diseases. After this period, the production was slow and most sporophores failed to reach maturity because of the severe attack of diseases and pests, especially mites. Production of the mushroom lasted for about a month. Since the aim of the second experiment was to find the most suitable among a number of well-developed spawns, the yield during the first six days would more or less indicate the excellence of each spawn; hence, the limited duration of observation in table 6.

Among the five kinds of spawn tested, fresh coffee pulp spawn produced the best results. This might be attributed to the high nutrient content of the material. A more important reason is that the rounded berry pulp served as an ideal substrate for mycelial growth. In the preparation of the bed, spawn were sown in between two layers of rice straw, then trodden and watered to make the bed more

TABLE 6.—*Summarized information on second experimental mushroom beds*

BED NO.	SPAWN MATERIAL AND AGE	DAY WHEN HIGHEST TEMPERATURE OCCURRED [a]	NUMBER OF DAYS TO FIRST PICKING	NUMBER OF SPOROPHORES HARVESTED DURING 1ST 6 DAYS	NUMBER OF WASTED SPOROPHORES DURING 1ST 6 DAYS	REMARKS
			days			
A	Ipil-ipil—7 weeks	8th day—44°C	25	36	2, due to mites	
B	Madre de cacao—12 weeks	6th day—49°C	28	10		Bed heavily infested with *Sordaria* sp.
C	Fresh coffee pulp—4 weeks	7th day—40°C	21	54	4, due to mites	
D	Fresh coffee pulp—4 weeks	6th day—40°C	17	102	8, due to mites	
E	Treated horse manure—8 weeks	7th day—43°C	23	8	2, associated with an actinomycete-like organism	Both beds E and F had a bed volume about half that of beds A, B, C, and D
F	Fresh corn cob—4 weeks	8th day—40°C	23	1	2, infested with maggots of mushroom fly	Bed heavily infested with *Sordaria* sp.

[a] Temperature was taken about five inches below bed surface.

compact. The mycelia on the spawn were subjected to external forces which would very likely injure or break the hyphae. The mycelia in the concave portion of the berry pulp received more protection than the other spawn. If the mycelia were less disturbed, they naturally would have developed better.

None of the beds were exempted from the infestation of a certain mesostigmatic mite. It was not uncommon to see 20 to 30 mites attacking a single button and the button eventually ceasing to grow. Another kind of mite, also found on the mushroom, was smaller, paler, and faster moving. It could cause great annoyance for it harbored on the less exposed portions of the human body and caused itching. Mites were the most prominent pests encountred.

Two cases of mushroom fly infestation were observed. The fly was identified as belonging to the family Mycetophilidae.[5] Numerous larvae were observed to tunnel into the growing button (fig. 6).

Fig. 6. Larvae of a mushroom fly. (*Photographed by Dr. B. V. Travis*).

[5] Identified and photographed by Dr. B. V. Travis, a Cornell professor.

These larvae probably hatched from eggs that were laid on the young button. Mushroom flies such as *Sciara* spp. belong to this same family. The maggot is reported to be destructive to the spawn besides burrowing into the cap and stem of champignon. The adult or fly (fig. 7) at times acts as a carrier of disease-producing spores and hypopi of mites (Metcalf and Flint, 1951).

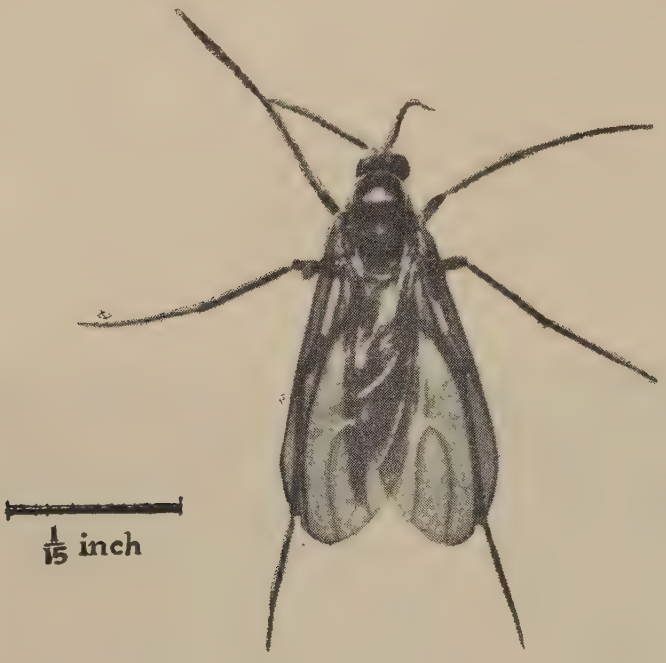

Fig. 7. Adult of a mushroom fly. (*Photographed by Dr. B. V. Travis*).

Two cases of infection by an actinomycete-like organism were observed in the culture house. Infection by this organism was previously noted in the first experiment. The occurrence of this organism was apparently favored by poor ventilation and prolonged high humidity in the enclosed culture house.

Bed B in the open-air culture and bed F in the culture house produced the poorest results. Both were heavily infested with *Sordaria* sp.[6] beginning with the second week of bed construction. The weed fungus grew so rapidly that within a week the bed was com-

[6] Prof. V. M. Ela of the Department of Plant Pathology helped in the identification of the fungus.

pletely covered with grayish mould, which later turned blackish due to the presence of black perithecia and dark olivaceous ascospores. The production of mushroom in bed B was delayed for about one week. Bed F produced only one sporophore. It was later examined and all of the corn cob spawn was found covered with *Sordaria*. Apparently the contaminant had outgrown the *Volvaria* mycelia and grew at the expense of the spawn.

Other fungi observed in the beds were three species of *Coprinus, Lepiota capaestipes* var. *cretaceous,* and a *Monilia* species. *Coprinus* grew on every bed and did not appear to have any detrimental effect on the cultivated mushroom. On bed D, *Lepiota* was observed, the general appearance of which was very similar to *Manilia fimicola* Cost. & Matr. in the photograph in a report by Charles and Lambert (1933). *M. fimicola* is considered one of the major diseases of champignon (Charles and Lambert, 1933; Beach, 1937).

Ants and rats, which were absent in the first experiment, were observed in this experiment.

A microscopic examination of a few samples from the rice straw bed revealed numerous yeast cells and nematodes, including cyst-forming ones. The presence of yeast was not surprising inasmuch as this organism undoubtedly takes part in the fermentation of carbohydrate materials. The nematodes had no direct harmful effects.

It is interesting to note that treated horse manure spawn were able to yield mushrooms. This showed that they were not damaged by insects or insect-like animals such as sowbugs.

SUMMARY AND RECOMMENDATIONS

1. There are at least two edible species of *Volvaria* commonly grown on rice straw. They have similar size and general appearance but they can be distinguished by their pileus. That of *V. volvacea* is whitish, covered with greyish to black fibrils, which are usually streaked and the umbo is much elevated. That of *V. bresadolae* (*V. esculenta* Bres) is ivory to straw-colored and covered with chestnut-brown fine fibrils; the umbo is not prominent.

2. The mushroom species (*V. volvacea* and *V. bresadolae*) grow better in warm than in cold temperature. They can be cultivated throughout the Philippines with the exception of cooler localities like Baguio City. In the laboratory, these organisms develop pro-

fuse mycelia from 30°C and above, and each optimum growth at 39 to 40°C. Fresh rice straw should be used to obtain higher temperature.

3. Like most fungi, *Volvaria volvacea* grows best in potato-dextrose agar; next best, in malt agar. In a potato-dextrose agar slant (¾" × 6" test tube), the culture remained viable up to six months and in a rice grain medium (1" × 8" test tube), up to nine months.

4. Since the pH value of rice straw is generally above 8.0, and the fungus grows well at such pH range, no particular attention is required concerning this aspect. However, if the pH of the bed can be lowered to 7.5, the optimum pH for this fungus, faster and more abundant mycelial growth may be obtained.

5. Fresh, dry rice straw should be used to minimize growth of competitive fungi. Weed fungi may overtake *Volvaria* in an old, moist substrate.

6. Owing to the severity of pests and diseases, a program of cultivation should include sanitary practices, together with pest and disease control. Since most of the pests observed were similar to those of champignon, the suggestions given by the workers in that field are worthy of consideration.

7. Fresh coffee pulp spawn was the best among a number of spawn tested. If treated horse manure spawn would be used, the dosage of insecticides may be considerably reduced so as to allow better mycelial growth and at the same time remain effective in repelling insects and other related animals. Nicotine or rotenone may be worthwhile trying in place of DDT, methoxychlor, and dylin.

8. In the experiments, the height of the rice straw beds was about 1¼ feet. For actual practice, however, the height may be raised considerably.

9. A location in the shade of trees or bamboos, or under a single nipa or cogon roof would be suitable for *Volvaria* cultivation. Enclosed places are not recommended because they are more conducive to disease development than the open-air shaded places.

10. The use of coconut husks or banana stalks as foundation for the bed is not important in mushroom culture. Although it is true that some mushrooms grew on banana stalks at the later part of the production, the number was not commensurate to the labor and

other expenses incurred in obtaining them. Coconut husks did not yield any mushroom. If adequate watering were provided, the husks would not be needed for the conservation of moisture. A soil foundation of about one-half foot in height would serve the purpose.

11. In harvesting, complete removal of the sporophore is important because any remnant may harbor pests and diseases. Harvesting mushrooms by cutting, therefore, should be avoided.

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THE OPERATIONS OF CORN WHOLESALERS, MILLERS, AND RETAILERS IN THE PHILIPPINES, 1956-57 [1]

BENJAMIN D. PEREDO

To find the mode of their operation, 28 corn wholesalers, 16 millers and 31 retailers were interviewed. Corn wholesalers operated during harvest or 1 to 2 months after. Davao and Cotabato wholesalers nearly operated the year round; while those from Batangas and Isabela did not. Of the total volume bought, 64 per cent was in husked form, 36 per cent shelled. Eighty-two per cent came from farmers, 12 per cent from agent buyers, and 6 per cent from private wholesalers. Of the total volume sold in shelled form, 66 per cent was channeled to private wholesalers, 17 per cent to NARIC and the balance distributed among the retailers, consumers, transient buyers, and commercial firms. The wholesalers obtained an average price margin of ₱2.53 per cavan shelled corn.

The corn mills studied had an average milling recovery of 57 per cent ground corn. Corn millers operated on the buy-mill-sell and custom bases. Those who operated on the buy-mill-sell basis obtained 61 per cent of their stock from private wholesalers and 39 per cent from farmers. Fifty-one per cent of the milled corn was sold to retailers, 34 per cent to private wholesalers, and the balance to consumers. farmers, and NARIC. Of the total volume milled on the custom basis, 98 per cent came from farmers. The same proportion was channeled back to farmers after paying an average milling fee of ₱0.25 per can of shelled corn or ₱1.03 per cavan of ground corn.

Majority of the corn retailers operated throughout the year with an average volume of 404 cavans of ground corn. Of the total volume handled, 65 per cent came from private wholesalers and 34 per cent from farmers. The retailers obtained an average price margin of ₱0.12 per ganta of ground corn.

Two of the most important factors of production that affect marketing are land and capital. The average Filipino farmer has a very limited farm size. This restricts the volume produced and marketed, as well as limits the farmers' choice of market outlets, time of sales, and bargaining power. Farms are also widely scattered and there is a lack of adequate system of roads and highways. This makes it difficult for farmers to market their produce at the right time

[1] Central Experiment Station Contribution No. 2025. Part of Project No. 1114 (NARIC). Prepared in the Department of Agricultural Economics under the direction of Dr. Lawrence B. Darrah, Cornell University visiting professor.

and right place. As a consequence, the normal flow of farm products is retarded, and this contributes to violent price fluctuation. Aside from this, the average farm capital is meager. This limits the use of necessary marketing facilities. Consequently, farmers encounter difficulty in storing and disposing their produce efficiently.

Due to these limitations—small production units, widespread farms, and lack of capital—the services of middlemen, private and governmental, are necessary in moving the farmers' produce.

The marketing of corn in the six major corn-producing provinces was generally in the hands of the middlemen.[2] Ninety-seven per cent of the total volume sold by farmers were distributed through them. The fact that the cost of marketing by farmers amounted to ₱0.80 per cavan of shelled corn, ₱0.11 cash cost and ₱0.69 non-cash cost and the average price margin received by wholesalers was ₱2.77 to ₱5.10 per cavan of shelled corn depending on the area involved, indicates that most of the services performed in marketing were done by middlemen. Chances are, most of the costs incurred by wholesalers were cash costs.

THE STUDY

This report is a part of a four-phase study of the marketing of corn in the Philippines. It represents the second, third, and fourth phases which include wholesaling, milling, and retailing of corn, respectively. The first phase, marketing of corn at the farm level, was completed.[3]

The wholesaling, milling, and retailing phases were conducted to determine the movement of corn from the time it leaves the farmer's hand until it reaches the consumer at the retail level. Preliminary data and information on (1) the marketing practices, (2) time of sales, (3) sources and market outlets, and (4) prices paid and received for corn will help the farmer determine how, where, and when his products should be marketed. This is expected to contribute to a more efficient marketing distribution system which will benefit both producer and consumer.

Twenty-eight corn wholesalers, 16 millers, and 31 retailers from six leading corn-producing provinces were interviewed. Two records

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[2] Peredo, B. D. "Marketing Corn at the Farm Level in the Philippines", *The Philippine Agriculturist*, **42**, 431-453 (1959).

[3] *Ibid.*

of the wholesalers were eliminated in the analysis because of inadequate data.

WHOLESALER MARKETING

Months of Operation. The majority of the corn wholesalers interviewed in Batangas, Isabela, Davao, and Cotabato operated from January to April (table 1). This is because rainfall during these months is lower than in the other months, thus favoring corn production.

TABLE 1.—*Proportion of wholesalers operating in each month, 28 corn wholesalers, Philippines, 1956-57*

MONTH	REGION				ALL
	Batangas	Isabela	Davao	Cotabato	
Wholesalers	10	2	7	9	28
			per cent		
January	30	50	57	78	54
February	50	50	71	67	61
March	80	100	57	44	64
April	90	100	43	89	78
May	30	—	43	78	46
June	—	—	57	78	39
July	—	—	43	56	28
August	10	—	57	44	32
September	20	50	57	44	39
October	20	50	71	33	39
November	20	100	71	33	43
December	10	50	43	44	36

The general practice of corn wholesalers in the four provinces was to operate during harvest or 1 to 2 months after. However, there was still geographical variation as to time of buying and selling. Corn wholesalers in Batangas and Isabela did not usually operate throughout the year, while those in Davao and Cotabato more nearly did. The reason is that Davao and Cotabato are near the corn-consuming areas, and farmers in these provinces produced more corn than those in Batangas and Isabela.

Kinds of Corn Product Handled. Husked and shelled corn were the two corn products handled by wholesalers. The operators preferred to buy corn in husked form. This form represented 64 per cent of the total purchases (table 2). The balance of the corn pur-

chased was in shelled form. The practice was to shell the husked corn bought so that wholesalers had only shelled corn for sale. Data on volume handled by wholesalers were either not available or unreliable and were therefore disregarded.

TABLE 2.—*Kind of products handled, 28 Corn wholesalers, Philippines, 1956-57*

KIND	BOUGHT	SOLD
	per cent	
Husked	64	—
Shelled	36	100
Total	100	100

Sources of Stock. Wholesalers obtained corn from three sources, namely: farmers, agent buyers, and private wholesalers. The farmers who provided 82 per cent of the total corn handled were the most important source (table 3). The agent buyers especially in Batangas, Davao, and Cotabato came next. Some of them, mostly Filipinos, operated on their own capital and others were financed by big wholesalers, particularly Chinese. Only in Davao were other wholesalers found to be important as a source of corn. These wholesalers were located in the centers of the production areas.

TABLE 3.—*Sources of stock, 28 corn wholesalers, Philippines, 1956-57*

SOURCES	PROVINCE				ALL
	Batangas	Isabela	Davao	Cotabato	
Wholesalers	10	2	7	9	28
			per cent		
Farmers	86	100	63	91	82
Agent buyers	12	—	17	9	12
Private wholesalers	2	—	20	—	6
Total	100	100	100	100	100

Outlets for Shelled Corn. Private corn wholesalers were the most important outlet of corn for the corn wholesalers studied. They accounted for 66 per cent of the total corn handled (table 4).

TABLE 4.—*Outlets for shelled corn, 28 corn wholesalers, Philippines, 1956-57*

BUYER	PROVINCE				ALL
	Batangas	Isabela	Davao	Cotabato	
Wholesalers	10	2	7	9	28
			per cent		
Private wholesalers	74	50	75	54	66
NARIC	6	—	3	46	17
Retailers	1	—	22	—	6
Consumers	8	—	—	—	3
Transient buyers	—	50	—	—	4
Commercial firms	11	—	—	—	4
Total	100	100	100	100	100

These private corn wholesalers were found in bigger market centers. In Batangas, local corn wholesalers sold primarily to corn wholesalers in Manila; in Isabela, to those located in Dagupan City; and in Davao and Cotabato, to wholesalers located in shipping points in other Mindanao and Visayan provinces. Second in importance as an outlet for wholesalers' corn was the National Rice and Corn Corporation, which keeps and distributes corn to stabilize prices in the consuming areas. Sales to retailers, transient buyers, and commercial firms were of minor importance.

In Cotabato, NARIC ranked second in importance as an outlet for wholesalers' corn. In Davao, retailers were the second most important outlet. Transient buyers were as important as other private wholesalers in Isabela. Sales to manufacturing firms were important only in Batangas. Examples of commercial firms were the Philippine Feeds, Philippine-American Milling Co., Araneta Institute of Agriculture, and San Miguel Brewery, Inc. These firms manufacture corn into animal feeds.

Prices. The average price paid by wholesalers for a cavan of shelled corn was ₱9.71; the average selling price, ₱12.24. This gave an average margin of ₱2.53 per cavan of shelled corn or a mark-up of about 26 per cent (table 5). Batangas wholesalers obtained the highest operating margin of ₱3.02 per cavan and Cotabato wholesalers, the lowest, ₱2.11.

TABLE 5.—*Average prices paid and received per cavan shelled corn, 26 corn wholesalers, Philippines, 1956-57*

PROVINCE	WHOLESALERS REPORTING	AVERAGE BUYING PRICE	AVERAGE SELLING PRICE	MARGIN
		pesos per cavan shelled corn		
Batangas	10	11.37	14.39	3.02
Isabela	2	8.40	10.97	2.57
Davao	7	9.60	11.77	2.17
Cotabato	7	7.83	9.94	2.11
All	26	9.71	12.24	2.53

CORN MILLS

The Mill. Corn mills varied in size and structure. Some were simple, others complex. Corn millers operating large scale buying and selling business usually owned big corn mills. Those operating on a custom milling basis in which they profit only from milling fees, owned small mills. Generally, most of the corn mills studied appeared antiquated.

The common corn mills were composed of three parts. The first part was used for shelling husked corn; the second, for grinding shelled corn; and the third, for blowing off particles unfit for human consumption. Oftentimes, the second and third parts were combined. The shelling machine was simpler in structure than the grinding and blowing machines. The latter have a number of outlets for ground corn and small particles of by-products. The grinding machine differs in three respects from the blowing machine. First, the grinding machine gives ground corn which has to be cleaned of small particles in the blowing machines. Thus, the blowing machine makes the final product (ground corn) fit and ready for consumption. Some corn mills do not have blowers. Second, the grinding machine also yields large particles of ground corn (corn grits) to be reground by the same machine. The production of various sizes of ground corn which need to be reground is affected by the operator's manipulation of a regulator. The number of operations, therefore, depends on how this regulator is handled. Besides the regulator, the grinding machine has a metallic sieve which separates particles of ground corn of different sizes. Lastly, the grinding machine differs from the blowing machine in that the former gives more by-products than the latter.

The mill was usually run by a self-generated motor and were found in barrios and towns patronized by farmers and/or corn consumers and retailers.

Sources of Corn Milled. Corn millers' operations consist of milling the corn they purchased and that of the consumers'. Sixty-one per cent of the millers' corn came from private wholesalers and the balance from farmers (table 6). About half of this corn was sold to retailers after milling. Thirty-four per cent was channeled to private wholesalers. Sales to consumers, farmers, and NARIC constituted 15 per cent of the total sales. Individually, they accounted for only a small part of the total sales. Of the amount of corn milled on a custom basis, 98 per cent came from farmers and 2 per cent from consumers. Custom milled corn reverted to the customers.

TABLE 6.—*Sources and outlets for corn mills, 16 corn millers, Philippines, 1956-57*

ITEM	OWN CORN	CUSTOM MILLED CORN
	per cent	
Sources:		
Farmers	39	98
Consumers	—	2
Private wholesalers	61	—
Outlets:		
Farmers	5	98
Private wholesalers	34	—
Retailers	51	—
NARIC	3	—
Consumers	7	2

Milling Fee. The common way of charging customers for the corn milled was on the basis of per-kerosene-can shelled corn. Kerosene can is used for convenience in milling. The milling fee ranged from ₱0.20 to ₱0.40 and averaged ₱0.25 per can of shelled corn. On the per-cavan-of-ground corn basis, the milling fee ranged from ₱0.80 to ₱1.60, and averaged ₱1.03. In cases where farmers did not have cash to pay for milling corn, millers retained a portion of their ground corn or its by-products the value of which was equivalent to the regular milling fee. This system of payment was practised by about half of the corn millers interviewed. The ground corn and by-products retained by corn millers were usually sold at retail.

Milling Recovery. The milling recovery was expressed in terms of per cent of initial weight remaining after milling. This was computed by dividing the weight of the recovered products by the weight of shelled corn and multiplying by 100.

In this study, corn millers reported an average milling recovery of 56.8 per cent ground corn and 27.6 per cent by-products. Loss amounted to 15.6 per cent (table 7).

TABLE 7.—*Milling recovery, 16 corn mills, Philippines, 1956-57*

ITEM	MILLING RECOVERY
	percentage weight
Ground corn	56.8
By-products	27.6
Losses	15.6
Total	100.0

RETAIL MARKETING

Months of Operation. Corn retailers in all provinces, except those in Batangas, usually operated throughout the year (table 8).

TABLE 8.—*Frequency of retailers operating in each month, 31 corn retailers, Philippines, 1956-57*

MONTHS	REGION						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
Retailers	1	4	6	8	9	3	31
				per cent			
January	100	100	83	38	89	100	77
February	100	75	83	25	89	100	70
March	100	75	100	25	89	100	73
April	100	75	100	38	100	100	80
May	—	75	100	50	89	100	80
June	100	75	100	38	89	100	77
July	—	75	83	50	89	100	77
August	100	75	83	62	100	100	83
September	100	100	83	62	100	100	97
October	100	75	83	38	89	100	73
November	—	75	83	50	89	100	77
December	—	75	83	38	89	100	73

Majority of the corn retailers in Negros Oriental, Cebu, Davao, and Isabela operated the year round. Whereas, corn retailers in Cotabato seemed not to have made a serious attempt to keep supplies on hand at all times.

Volume and Kinds of Corn Product Handled. The average volume handled during the whole period of operation was 404 cavans ground corn. Corn retailers in Davao, Cotabato, and Negros Oriental handled the largest volume and those in Isabela, the lowest (table 9).

TABLE 9.—*Average volume handled, 31 corn retailers, Philippines, 1956-57*

PROVINCE	NUMBER REPORTING	VOLUME HANDLED
		cavans ground corn
Batangas	1	32
Isabela	3	207
Davao	5	672
Cotabato	9	473
Cebu	3	236
Negros Oriental	9	397
All	31	404

The practice of the retailers was to purchase ground corn and shelled corn. Of the total volume bought for retailing, 63 per cent was ground corn and 37 per cent, shelled corn. The latter was milled and retailers had only ground corn for sale.

Sources of Stock. Private wholesalers presented the main source of corn of retailers. Sixty-five per cent of the total volume handled came from them (table 10). Chances are, part of this amount came from wholesalers who were also corn millers in the locality and the rest from wholesalers located in shipping points of the provinces. Farmers were the second most important source, representing 34 per cent of the total volume handled. Retailers in Batangas and Isabela obtained all their supplies from farmers, whereas those in Davao and Cotabato procured most of their supplies from private wholesalers. In Cotabato, farmers were almost as important as private wholesalers as a source of corn. Agent buyers in Negros Oriental were fairly important.

TABLE 10.—*Sources of stocks, 31 retailers, Philippines, 1956-57*

SOURCE	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
Retailers	1	4	6	8	9	3	31
				per cent			
Farmers	100	100	14	45	4	20	34
Agent buyers	—	—	—	—	—	20	1
Private wholesalers	—	—	86	55	95	60	65
NARIC	—	—	—	—	1	—	*
Total	100	100	100	100	100	100	100

* Less than one per cent.

Prices. The practice of the retailers was to buy ground and shelled corn (the latter milled) on a cavan basis and retail ground corn on a ganta basis. Since the number of gantas in a cavan varies from place to place, only price comparisons in this study were for those purchases and sales made on the per-ganta-of-ground-corn basis. The average buying price of the retailers was ₱0.46 per ganta of ground corn and the average selling price, on the same basis, was ₱0.58 (table 11). This gave the retailers an average margin of ₱0.12 per ganta ground corn.

TABLE 11.—*Prices paid and received, 31 corn retailers, Philippines, 1956-57*

KIND	AVERAGE BUYING PRICE	AVERAGE SELLING PRICE	AVERAGE MARGIN
		pesos	
Shelled:			
Per cavan	10.68	—	—
Ground:			
Per cavan	15.42	—	—
Per ganta	0.46	0.58	0.12

NOTE: CORRELATION STUDIES OF THE ENDOSPERM AND EMBRYO SIZE OF THE PHILIPPINE RECOMMENDED RICE VARIETIES [1]

In connection with radiation studies being undertaken on rice, it is important to run an auxiliary study to obtain a correct interpretation of the radio-sensitivity of the different recommended rice varieties. If larger seed size is due to greater endosperm size and if this quality is correlated with susceptibility to X-ray treatment, then it might be that susceptibility to X-rays is an effect on the nutrition rather than on the embryo itself.

As a preliminary towards verifying this possibility, one hundred seed samples each of upland and lowland recommended varieties were dehulled and with the aid of a Vernier caliper, the size of the endosperm was taken (in mm.). Embryo size was obtained from the same seed samples. Sections of it were made from the tip of the coleoptile to the apex of the coleorhiza and stained with aceto-orcein. Measurement was taken with the ocular micrometer under the low power objective. Subsequent conversion to millimeters was made.

Statistical analyses were based on ten random samples of each variety.

RESULTS

Tables 1 and 2 indicate the mean values of the endosperm and

TABLE 1.—*Mean and r value of the endosperm and embryo size of the recommended upland varieties*

	MEAN OF 10 SAMPLES		*r* VALUE
	Endosperm	Embryo	
Azucena	7.93	1.09	.033
Fortuna	7.51	1.16	.055
Kinandang Puti	5.70	1.04	.770 *
Magsanaya	7.20	1.14	.590
Palawan	5.70	1.13	.196
Pinulot	5.60	1.02	.342
Nagdami	5.80	1.17	.323

[1] Rice and Corn Research Project No. 15.

TABLE 2.—*Mean and r value of the endosperm and embryo size of the recommended lowland varieties*

	MEAN OF 10 SAMPLES		*r* VALUE
	Endosperm	Embryo	
Tjahaja	7.40	1.10	.094
Intan	6.90	1.01	.654 *
Tjeremas	7.40	1.08	.820 *
B-E-3	6.60	1.12	.653 *
Raminad	6.70	1.10	.313
Seraup Kechil 36	5.90	1.09	–.030
Peta	6.80	1.16	.485

r .05 = 0.632
.01 = 0.735
d.f. = 8

embryo size for each variety and their corresponding correlation coefficients. With the exception of the variety 'Kinandang Puti', all upland varieties showed that the coefficient of correlation between endosperm and embryo size were not significant. Among lowland varieties, 'Intan, Tjeremas, and B-E-3' showed positive correlation. Variety 'Seraup Kechil 36', however, exhibited a negative *r* value, though not significant. All other varieties did not have significant correlations.

The above results would serve as one of the criteria for the interpretation of data on the radio-sensitivity of the recommended rice varieties. Should the varieties exhibiting positive correlation between endosperm and embryo size show marked reaction to X-rays, such a result could be partially explained on the basis of endosperm-to-embryo ratio.

—Filomena F. Campos and Lucila G. Espiritu[2]

[2] The authors are grateful to Dr. J. M. Capinpin and Mr. A. D. Yñiguez for suggestion and advice.

NOTE: EFFECTS OF GIBBERELLIN ON YOUNG ABACÁ PLANTS INFECTED WITH THE MOSAIC DISEASE

There have been continuous reports that Gibberellin, a growth promoting chemical, has stimulated growth of stunted plants infected with virus diseases. To confirm these reports, 4 potted abaca seedlings infected with mosaic were prepared. They were treated with different concentrations of Gibberellin, namely, 25 ppm, 50 ppm, 100 ppm, 150 ppm, and 200 ppm. The same number of infected seedlings were alloted for the control.

The experimental plants received 2 cc. each of the solution applied at the growing point of the plants with a clean 10 cc. pipette. To avoid run-off of the solution, cotton was wrapped around the topmost portion of the pseudo-stem. The control seedlings received 2 cc. of distilled water. Subsequent treatments of the experimental plants were made at weekly intervals.

The initial heights of both the control and the treated plants were taken to serve as basis for growth evaluation. One week after the first treatment, the height of the experimental plants and the controls were compared. Subsequent weekly measurements were made up to the fourth week. The evaluation of the best concentration of Gibberellin that stimulated growth of the stunted abaca mosaic seedlings was based on the comparison of the average weekly heights.

RESULTS

Weekly measurements of height of the experimental plants indicated that Gibberellin greatly stimulates growth. However, there was no uniform height attained by the plants. It has been noted that 100 ppm of Gibberellin appeared to be the optimum concentration which greatly stimulated growth. At this concentration, the plants were also observed to be less susceptible to stem-rot disease. The 100 ppm treated plants attained an average height of 56.16 centimeters a week after the fourth application. It was followed by treatments of 150 ppm with an average height of 51.50 centimeters. Two of the plants treated with 150 ppm died of stem rot and all of the plants treated with 200 ppm Gibberellin succumbed after the

fourth week. However, the plants treated with 50 ppm and 25 ppm resisted the disease but have shorter height of 44.53 and 42.10 centimeters, respectively. The check plants have an average height of 26.05 centimeters (table 1).

TABLE 1.—*Results showing the relative effects of varying concentration of Gibberellin upon the growth of abaca mosaic-infected seedlings*

TREATMENT	WEEKLY AVERAGE HEIGHT IN CENTIMETER				
	Initial	I	II	III	IV
200 ppm	15.82	30.15	35.00	42.60 *	**
150 ppm	15.22	25.95	33.00	44.80 *	51.50 *
100 ppm	16.50	37.77	41.27	48.16	56.16
50 ppm	18.95	30.05	36.80	39.80	44.53
25 ppm	17.62	29.40	34.92	41.76	42.10
Control	16.12	22.70	24.57	25.60	26.05

* Two plants died of stem rot
** All the plants succumbed to stem rot.

In general, Gibberellin did not affect the mosaic patterns. Although there was positive growth stimulation, the mosaic virus remained infective. This was shown by the following transmission experiment performed. *Aphis gossypii* were allowed to feed on the mosaic-infected plants previously treated with 100 ppm of Gibberellin. The aphids were later transferred to healthy abaca seedlings and after 2 weeks of incubation, all the seedlings were infected with the disease.

The treated plants had soft and tender pseudo-stems and were more elongated than the control. The leaves which still carry mosaic symptoms become more elongated and narrower and sometimes appeared wrinkled. They also tended to droop due to the weak and frail pseudo-stems (fig. 1).

—*V. M. Ela, G. O. Ocfemia, and R. G. Davide* [1]

[1] The writers are grateful to Merk, Sharp & Dohme (Philippines) Inc. for providing them with "Gibrel" and to C. Itoh & Co., Ltd., with gibberellin "Kyowa" for use in the test.

Fig. 1. Growth stimulation of Gibberellin on abaca mosaic-infected seedlings. Note the varying height of the plants and the mosaic patterns on the leaves. (1) Control; (2) 25 ppm of Gibberellin; (3) 50 ppm; (4) 100 ppm; (5) 150 ppm. (*Photographed by the Photographic Division*).

NOTE: CYTOLOGY OF PHILIPPINE PLANTS. IV. *STRONGYLODON MACROBOTRYS* A. GRAY

Jade-vine (*Strongylodon macrobotrys* A. Gray), an ornamental vine belonging to the bean family (Leguminosae), is indigenous to the Philippines.[1] It has a big racemose inflorescence with bluish-green flowers, which makes this plant unusually attractive. Jade-vine is rapidly gaining popularity in the flower nurseries and flower gardens throughout the country.

Jade-vine was found to have 9 pairs of chromosomes at diakinesis (fig. 1) or a somatic chromosome number of 18. The chromosomes spread fairly well at diakinesis and in several instances it was observed that a group of three bivalents tended to clump and were somewhat isolated from the rest. All the meiotic stages, except Anaphase I, where chromosome bridges were evident (fig. 2), seemed normal. Pachytene analysis was not done on account of the minute size of the pollen mother cells and the compactness of the pachytene threads.

Fig. 1. Camera lucida drawing of Jade-vine sporocyte at diakinesis. ($n = 9$).

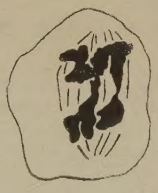

Fig. 2. Camera lucida drawing of Jade-vine PMC at Anaphase I.

—*Dolores A. Ramirez*

[1] Juan V. Pancho, *Baileya* **3**, 68-69 (1955).

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